

***Chromodoris magnifica* (Quoy & Gaimard, 1832),
a new nudibranch host for the shrimp
Periclimenes imperator Bruce, 1967 (Pontoniinae)**

C.H.J.M. Fransen & J. Goud

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C.H.J.M. Fransen & J. Goud, Nationaal Natuurhistorisch Museum, Postbus 9517, 2300 RA, Leiden, The Netherlands, e-mail: fransen@naturalis.nnm.nl, goud@naturalis.nnm.nl.

Key words: Crustacea; Decapoda; Caridea; Pontoniinae; *Periclimenes imperator*; Mollusca; Nudibranchia; *Chromodoris magnifica*; new association.

During the NNM/Maluku Expedition 1996, in the framework of the NNM Fauna Malesiana Marine Program, a shrimp belonging to the species *Periclimenes imperator* Bruce, 1967, was found on a nudibranch while diving at 20 m depth in Seri Bay, on the south coast of Ambon. *Periclimenes imperator* has been recorded throughout the tropical Indo-West Pacific, from East Africa and the Red Sea to Hawaii, from nudibranch and holothurian hosts.

The nudibranch was identified as *Chromodoris magnifica* (Quoy & Gaimard, 1832) (see Rudman, 1982: 216-219, figs. 17A, B, 18, 19). The association with *Chromodoris magnifica* is recorded here for the first time.

The Maluku Expedition 1996 was a joint coastal marine zoological research program of the National Museum of Natural History (NNM), Leiden, and the Pusat Penelitian dan Pengembangan Oseanologi (PPPO) in co-operation with the Balai Penelitian dan Pengembangan Sumberdaya Laut of LIPI-PPPO on Ambon.

Abbreviation: pool.= post orbital carapace length.

***Periclimenes imperator* Bruce, 1967**
(figs 1-4)

Material.— 1 male, pool. 1.47 mm (RMNH D 47515): Sta. MAL.24; Ambon, Seri Bay, 03°45'S 128°09'E; scuba diving; 22.xi.1996; on *Chromodoris magnifica*; leg. J. Goud.

Reference material.— 1 male, pool. 1.49 mm (RMNH D 47516): Sta. MAL.12: Ambon, N coast near

Morela, 03°33'S 128°12'E; 13/14.xi.1996; depth 15 m; diving; on *Stichopus* spec.; leg. C.H.J.M. Fransen. Material referred to by Fransen (1994a) from the Seychelles and Fransen (1994b) from Ambon, Indonesia.

The specimen (RMNH D 47515) found on the new host *Chromodoris magnifica*, has 17 dorsal rostral teeth and a scar at the location of the epigastric spine (fig. 1). The ventral margin of the rostrum bears an indistinct subdistal tooth. The basal segment of the antennular peduncle has one distolateral tooth. The first pereiopods have the cutting edges distally pectinate. The accessory spines of the dactylus of the third to fifth pereiopod are small but distinct. The basicerite bears a small lateral spine.

The specimen found on *Stichopus* (RMNH D 47516) is similar to the former specimen, except that the rostrum bears 19 dorsal teeth.

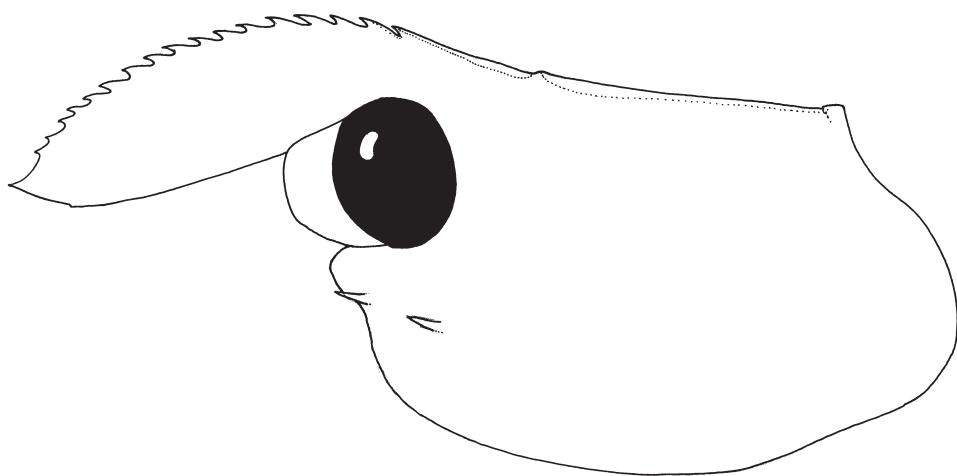


Fig. 1. *Periclimenes imperator* Bruce, 1967, male specimen RMNH D 47515, pool. 1.47 mm, lateral aspect of carapace.

Taxonomy.—The distinction between *P. imperator* and *P. rex* Kemp has been discussed by Bruce, 1967. Except for the holotype specimen described by Kemp (1922) from the Andaman Islands, records of *P. rex* have been assigned to *P. imperator* (see below) or *Periclimenes soror* Nobili, 1904 (MacNae & Kalk, 1958: 75; 1962: 111, 118).

Several of the morphological differences between *P. rex* and *P. imperator* indicated by Bruce (1967) have faded away when more material became available.

Bruce (1967: 61) indicated four characters to separate *P. imperator* from *P. rex*. These characters are discussed in relation to recent observations.

1. "The absence of an epigastric spine in *P. imperator*. Kemp illustrated an epigastric spine and described it in his text for *P. rex*."

In the specimens under study a distinct scar is present at the location of the epigastric spine (fig. 1). This has also been observed in material recorded by Fransen (1994a) from the Seychelles and Fransen (1994b) from Ambon. Although an epigastric spine has never been encountered in specimens of *P. imperator*, the presence of the scar could be an indication that it can sometimes be present.

2. "The presence of two or more distolateral spines on the basal segment of the antennular peduncle. Kemp described and illustrated only a single spine in this position in *P. rex*."

Fransen (1994a: 123-124) described the variation in the number of distolateral teeth on the basal segment of the antennular peduncle in a collection of *P. imperator* made at the Seychelles. It was found that the majority of specimens had only one distolateral tooth.

3. "The pectinate distal ends of the cutting edges of the fingers of the first pereiopod in *P. imperator*. Kemp did not specifically describe the cutting edges of the first pereiopods in *P. rex* but as he observed a similar pectination in other species of *Periclimenes* it is unlikely that he overlooked its presence in the single species of *P. rex* that was available to him."

A distally pectinate cutting edge is present in all specimens examined herein. Re-examination of the holotype specimen of *P. rex* could clear this up.

4. "The obsolescent accessory spines of the dactylus of the third to fifth pereiopods in *P. imperator*. These are distinct although small in the only known specimen of *P. rex*."

The present specimens and several specimens from the Seychelles (Fransen, 1994a) show the accessory spine as described for *P. rex*. It seems the variation of this character is considerable.

Other characters like the number of dorsal rostral teeth vary in the Seychelles collection (Fransen, 1994a: 123-124); the 21 dorsal rostral teeth described for *P. rex* are within the range (17-27) of the material examined.

The two species cannot be distinguished by colour. The colour pattern described by Kemp (1922) for *P. rex* is detailed and exactly matches the colour-pattern of the specimen of *P. imperator* figured (figs. 1, 2).

The fact that *P. rex* has never been recorded since its discovery suggests that it is, in fact, conspecific with *P. imperator*. However, pending examination of the holotype we refrain from formally synonymising the names *P. imperator* Bruce, 1967, and *P. rex* Kemp, 1922. The holotype of *P. rex* is in the Zoological Survey of India, Calcutta, but we failed in our efforts to get the specimen on loan. The remaining differences between the two species are the pectinate versus non-pectinate cutting edges of the first pereiopods, and the absence versus presence of a small lateral spine on the basicerite.

Hosts.—*Periclimenes imperator* Bruce, 1967, was originally described from Zanzibar, Moçambique, the Red Sea and Hawaii, from nudibranchs. The Zanzibar and Moçambique specimens were found on *Hexabranchus marginatus* (Quoy & Gaimard, 1832), the Hawaii specimen on an unidentified dorid nudibranch. Since 1967, the species has been recorded on mollusc and echinoderm host species. The records on the various host species published so far are listed in table 1.

Table 1. List of recorded hosts of *Periclimenes imperator*. For the classification of Mollusca we followed Beesley et al., 1998. The classification of Echinodermata is according to Fell, 1982. Geographic data, as far as provided, are added between brackets. We have completed the names of the hosts with author and year of publication as far as we could.

Subclass Orthogastropoda

Superorder Caenogastropoda

Order Sorbeoconcha

Suborder Hypsogastropoda

Family Cypraeidae

Cypraea tigris Linnaeus, 1758: Debelius, 1996: 122, colour fig. 1 (Indo-Pacific); Paolillo, 1997: 70, colour fig. (Seychelles).

Subclass Opistobranchia

Order Notaspidea

Family Pleurobranchidae

Pleurobranchus forskalii Rüppell & Leuckart, 1828: Colin & Arneson, 1995: 220, colour fig. 1045 (Kalihi Harbor, Papua New Guinea).

Pleurobranchus grandis Pease, 1868: Colin & Arneson, 1995: 178 (Port Moresby, Papua New Guinea)

Order Nudibranchia

Unidentified nudibranch: Bruce, 1967: 53-62, figs. 23-25 (Madagascar, Zanzibar, Red Sea).

Suborder Doridina

Superfamily Anadoridoidea

Family Polyceridae

Tambja spec.: Drogan, 1997 (Lembeh Strait, Sulawesi, Indonesia).

Family Gymnodorididae

Gymnodoris aurita (Gould, 1852): Debelius, 1996: 123, colour fig. 8 (Philippines); Behrens, 1998.

Superfamily Eudoroidea

Family Hexabranchidae

“Spanish Dancer”: Schmid & Paschke, 1990: 92, 93, colour fig. (Red Sea).

Hexabranchus spec.: Monod, 1968: 772 (Noumea, New Caledonia); Bruce, 1968: 1166 (New Caledonia); Bennett, 1971: 120 (Great Barrier Reef, Australia); Doubilet, 1975: 348, 2 colour figs. (Red Sea); Hunziker, 1993: 74; Fransen, 1994a: 123-124, pl. 3 fig. C (Seychelles); Severns, 1994: 54, 55, colour fig. (Sulawesi, Indonesia).

Hexabranchus flammulatus (Quoy & Gaimard, 1832): Coleman, 1977: 124 (Queensland, Australia).

Hexabranchus marginatus (Quoy & Gaimard, 1832): Bruce, 1967: 53-62, fig. 23-25 (Zanzibar, Mocambique); Bruce, 1972: 222-224, colour fig.; Shoup, 1972: 109-111, pl. 1 (Hawaii); Bruce, 1973: 135-136 (Mahé, Seychelles); Bruce, 1976a: 477 (Kenya); Schumacher, 1976: 216, colour fig. 112 (Great Barrier Reef, Australia).

Hexabranchus sanguineus (Rüppell & Leuckart, 1828): Bruce, 1968: 1166 (New Caledonia, as *Hexabranchus imperialis* Kent, 1897); Castro, 1971: 396 (Hawaii; as *Hexabranchus aureomarginatus* Ostergaard); Schumacher, 1973: 355-360, fig. 1 (Red Sea); George & George, 1979: 76, fig. 68/4; Bruce, 1980: (Great Barrier Reef, Australia, as *Hexabranchus sanguinolentus*); Bruce, 1981: 16-17 (Heron Island, Great Barrier Reef, Australia); Debelius, 1982: 424, 425, 2 colour figs (Red Sea); Debelius, 1983a: 433-436; Debelius, 1983b: 91, 93, colour fig. (Red Sea); Vine, 1986: 102, 103, 150 (Red Sea); Doubilet, 1989: 44, colour fig. (Marsa el Muqabelah, Egypt); Steene, 1990: 54, colour fig. (Bali, Indonesia, as *Hexabranchus sanquinensis*); Baensch & Debelius, 1992: 528, 529, colour fig. (Indo-Pacific); Strack, 1993: 55, pl. 3 fig. 1 (Amboin, Indonesia); Fransen, 1994b: 106, pl. 2 fig. 6 (Amboin, Indonesia); Debelius, 1996: 123, colour fig. 6 (Red Sea); Paolillo, 1997: 144-145, colour figs. (Seychelles); Schmid, 1997: 156, 158, colour figs. (Red Sea); Fosså & Nilson, 1998: 144, colour fig. (Heron Island, Great barrier Reef, Australia).

Family Dorididae

Dorid nudibranch: Bruce, 1967: 53 (Hawaii).

Family Discodorididae

Discodoris boholiensis Bergh, 1877: Debelius, 1996: 247 (Bali, Indonesia).

Family Chromodorididae

Risbecia tryoni (Garret, 1873) (identified from photographs by J. Goud): Banfi, 1996a: 129, fig. I (Papua New Guinea); Banfi, 1996b: 77, colour fig. (Milne Bay, Palua New Guinea, 5 m depth); Debelius, 1996: 122, colour fig. 4 (Indo-Pacific, as *Risbecia* spec.); Erhardt & Baensch, 1998: 870, colour fig. (N Sulawesi, Indonesia).

Chromodoris tintoria (Rüppell & Leuckart, 1828): Rudman, 1998 (Koumac, New Caledonia).

Family Dendrodorididae

Dendrodoris tuberculosa (Quoy & Gaimard, 1832): Castro, 1971: 396 (Hawaii).

Phylum Echinodermata

Class Holothuroidea

Unidentified holoturian: Bruce, 1975: 49 (as *P. rex*); Bruce, 1976c: 84, fig. 1 (Heron Island, Great Barrier Reef, Australia); Laboute & Magnier, 1979: 26 (New Caledonia); Debelius, 1982: 424, 425, 2 colour figs (Red Sea); Debelius, 1983a: 434, 435, fig. 1; Debelius, 1983b: 91 (Red Sea); Patzner & Debelius, 1984: 111-112, colour fig.; Fransen, 1994a: 123 (Seychelles); Newbert, 1994: 95, colour fig., 200 (Coral Sea, Australia); Severns, 1994: frontispiece, 160, colourfig. (Sulawesi, Indonesia); Paolillo, 1997: 33, colour fig. (Seychelles); Schmid, 1997: 156, 158, colour fig. (Red Sea); Cangini, 1998: 39,

colour fig. (Red Sea).

Subclass Aspidochiroacea

Order Aspidochirotida

Family Holothuriidae

Actinopyga hannwarthi Panning, 1944: Schumacher, 1973: 355-360 (Red Sea); Bruce, 1978a: 170 (Queensland, Australia).

Bohadschia argus Jaeger, 1833: Bruce, 1983: 208 (Bligh Reef, Australia); Fosså & Nilsen, 1998: 3, 144, colour fig. (Sulawesi, Indonesia).

Bohadschia spec.: Bruce, 1976a: 477 (Kenya); Bruce, 1976b: 16 (Kenya).

Holothuria (Microthelus) fuscopunctata Jaeger, 1833: Bruce, 1991: 237 (New Caledonia).

Family Stichopodidae

Stichopus spec.: Bruce, 1975: 49; Bruce, 1978a: 170 (Queensland, Australia); George & George, 1979: 76.

Stichopus chloronotus Brandt, 1835: Bruce, 1971: 10-11 (Comore Islands).

Stichopus imperialis: Darom & Por, 1976: 62, colour fig. (Red Sea).

Stichopus variegatus Semper, 1868: Bruce, 1976a: 477 (Kenya); Coleman, 1977: 124 (Great Barrier Reef, Australia); Bruce & Svoboda, 1983: 9, 10, fig. 2 (Aqaba, Jordan, Red Sea); Bruce, 1993: 68 (Vietnam).

Thelenota ananas (Jaeger, 1833): Hipeau-Jacquotte, 1973: 105 (Madagascar, as *P. rex*); Bruce, 1978: 203; Bruce, 1983: 208 (Heron Island, Great Barrier Reef, Australia); Fransen, 1994a: 123, Pl. 3C (Seychelles).

Subclass Apodacea

Order Apodida

Family Synaptidae

Unidentified synaptid: Jacquotte, 1964: 181 (Madagascar, as *P. rex*); Hipeau-Jacquotte, 1973: 105 (Madagascar, as *P. rex*); Debelius, 1996: 220, colourfig. 1044 (Papua New Guinea); Bruce, 1996: 234 (New Caledonia).

Euapta godeffroyi (Semper, 1868): Schumacher, 1973: 355-360 (Red Sea); Bruce, 1978a: 170 (Queensland, Australia).

Opheodosoma spectabilis Fisher, 1907: Bruce, 1976a: 477 (Zanzibar).

Synapta spec.: George & George, 1979: 76, fig. 68/3; Coleman, 1977: 124 (Great Barrier Reef, Australia).

Synapta oceanica (Lesson, 1830): MacNae & Kalk, 1962 (Inhaca, Mocambique, as *P. rex*); Jacquotte, 1964 (Tuléar, Madagascar, as *P. rex*).

Synapta maculata (Chamisso & Eysenhardt): Bruce, 1978b: 230; Müller, 1993: 106.

Classis Stelleroidea

Subclass Asteroidea

Order Valvatida

Family Ophidiasteridae

Gomophia egyptiaca Gray, 1840; Vine, 1986: 102, 103, 150 (Red Sea).

Classis Crinoidea

“Federsternen”: Baensch & Debelius, 1992: 528, colour fig. (Indo-Pacific).

“Haarstern”: Fosså & Nilson, 1998: 144, colour fig. (Sulawesi, Indonesia).

No host recorded: Barnard, 1955: 47 (Delagoa Bay, South Africa, as *P. rex*); Li & Liu, 1993: 36 (Hainan, China).

The identity of the shrimps recorded from crinoid and asteroid hosts referred to in table 1 as *P. imperator*, is doubtful. *Periclimenes soror* Nobili, 1904, a species related to *P. imperator*, usually associates with asteroids (see Fransen, 1997) and may show a similar colour pattern as *P. imperator*. The photograph by Baensch & Debelius (1992: 528) of a shrimp referred to as *P. imperator*, on a crinoid (Baensch & Debelius, 1992: 528, colourfig.) shows a colour pattern slightly different from *P. imperator*. The mor-



Fig. 2, 3. *Periclimenes imperator* Bruce, 1967, male specimen RMNH D 47515, pocl. 1.47 mm, on *Chromodoris magnifica* (Quoy & Gaimard, 1832).

phology of specimens with this colour pattern should be studied to see if they are conspecific with *P. imperator*. The specimen figured by Fosså & Nilson (1998: 144), also on a crinoid, has an even more different colour pattern, and could well represent another species. For species of the genus *Periclimenes* associated with crinoids, see Fransen, 1997.

Colour.— Shrimps found on *Hexabranchus sanguineus* usually match their colour pattern with that of the host (Fransen, 1994b: pl. 2 fig. 6), often showing a uniform pattern of yellow-white dots on a dark red background. However, on several occasions a pattern with distinct dorsal white areas on carapace and abdomen, flanked by dark red lateral surfaces has been observed (Shoup, 1972: pl. 1). Shrimps occurring on holothurians show a more constant colour pattern, as shown in fig. 2 and 3 (see also Fransen, 1994a: pl. 3 fig. c). The larger the specimen the more intense the coloration generally is (Debelius, 1983b: 435 fig. 4; Patzner & Debelius, 1984). In the present specimen the colour pattern is the same as the pattern of the shrimps associating with holothurians. Debelius (1983a) observed a change in colour pattern of the shrimp when moved from a *Hexabranchus* host to a holothurian host. This indicates that the colour pattern can be adapted actively by the shrimp. A photograph of an unidentified synaptid holothurian (Debelius, 1996: 221, fig. 1044) shows a specimen of *P. imperator* with a 'Hexabranchus'-type of colour pattern.

MacNae & Kalk (1962: 118) described the colour pattern of a specimen referred to as *P. rex* as: "a royal blue". Bruce (1965: 493) noted that such specimens are in fact *Periclimenes soror* Nobile, 1904.

Biology.— Schumacher (cf. Debelius, 1983a) observed in the Red Sea that the shrimp did not leave its host (*Hexabranchus* spec.) when the latter was swimming. In the aquarium he observed the shrimp eating particles from the sticky surface of the nudibranch and sometimes also the nudibranch's excrements. Shoup (1972) also observed the shrimps reaching over the edge of the nudibranch, picking up material from the substrate upon which the nudibranch was resting. As suggested by field observations, shrimps associating with nudibranchs seem to rely more on their camouflage than those associating with holothurians. The pair of shrimps found on *H. sanguineus* on the north coast of Ambon (Strack, 1993) remained in sight of the observer, seeking shelter near the gills of the slug and moving slowly over the host. The shrimps living on holothurians were observed to move to the opposite side of the host hiding from the observer. They moved very quickly over the host's surface, more or less jumping from one side to the other, subsequently remaining motionless again. They also tended to stick to their host when disturbed, as has been observed by us on several occasions in the Seychelles and in Indonesia.

Shoup (1972) noted that when in aquarium conditions a shrimp removed from *H. sanguineus* was placed in another aquarium housing a nudibranch already hosting a shrimp, the introduced shrimp immediately jumped on the nudibranch. The intruder was subsequently attacked by the other shrimp and chased off the slug.

Bruce (1983: 9-10) moved shrimps from the holothurian *Stichopus variegatus* to the nudibranch *H. sanguineus*. Even over a distance of 20 m, the shrimps returned to their original host. Schumacher (Patzner & Debelius, 1984) gave shrimps from *Hexa-*



Fig. 4. *Periclimenes imperator* Bruce, 1967, on *Chromodoris tinctoria* (Rüppell & Leuckart, 1828), Koumac, New Caledonia. Courtesy B. Rudman.

branchus sanguineus the choice between their original host and a holothurian. These shrimps too chose to go back to their original host. Bruce (1976e: 72) noted that small specimens occur on the holothurian hosts while large specimens live on *Hexabranchus* slugs. We cannot confirm this on the basis of the reference material studied.

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References

Allen, G.R. & R. Steene, 1994. Indo-Pacific coral reef field guide: i-vi, 1-378.— Singapore.

Baensch, H.A. & H. Debelius, 1992. Meerwasser Atlas. Die gemeinsame Pflege von Wirbellosen Tieren und tropischen Meeresfischen im Aquarium: 1-1216.— Mell, Germany.

Banfi, F., 1996a. Papua-Neuguinea. Tauchführer: 1-167.— Hamburg, Germany.

Banfi, F., 1996b. Papua Nieuw-Guinea: 1-160.— Lisse, The Netherlands.

Barnard, K.H., 1955. Additions to the fauna-list of South African Crustacea and Pycnogonida.— Annals of the South African Museum 43: 1-107, figs. 1-53.

Beesley, P.L., G.J.B. Ross & A. Wells (eds), 1998. Mollusca: The southern synthesis.— Fauna of Australia, vol. 5, part A: i-xvi, 1-563; part B: i-viii, 565-1234.

Behrens, D.W., 1998. Nudibranch of the week is *Gymnodoris aurita*. The Slug Site.— <http://siolibrary.ucsd.edu/slugsite/nudiwk58.html>.

Bennett, I., 1971. The Great Barrier Reef: 1-183.— London.

Bruce, A.J., 1965. Notes on Indo-Pacific Pontoniinae. X. *Periclimenes cristimanus* sp. nov., a new pontoniinid shrimp from Singapore.— Annals and Magazine of natural history (13) 8: 487-493, figs. 1-2.

Bruce, A.J., 1967. Notes on some Indo-Pacific Pontoniinae, III-IVCX. Descriptions of some new genera and species from the western Indian Ocean and South China Sea.— Zoologische Verhandelingen Leiden 87: 1-73, figs. 1-29.

Bruce, A.J., 1968. A report on some pontoniid shrimps from New Caledonia. (Crustacea Decapoda Natantia).— Bulletin du Muséum National d'Histoire naturelle, Paris (2) 39 (6): 1148-1171, figs. 1-10.

Bruce, A.J., 1971. Pontoniinid shrimps from the ninth Cruise of the R/V Anton Bruun, I.I.O.E., 1964: 1. *Palaeomonella* Dana and *Periclimenes* Costa.— Smithsonian Contributions to Zoology 82: 1-13, fig. 1.

Bruce, A.J., 1972. Shrimps that live with molluscs.— Sea Frontiers 18(4): 218-227, illustrated.

Bruce, A.J., 1973. The pontoniinid shrimps collected by the Yale-Seychelles Expedition, 1957-58 (Decapoda, Palaemonidae).— Crustaceana 24 (1): 132-142, figs. 1-2.

Bruce, A.J., 1975. Shrimps that live on echinoderms.— Sea Frontiers 21 (1): 44-53, figs. 1-10.

Bruce, A.J., 1976a. A synopsis of the pontoniinid shrimp fauna of Central East Africa.— Journal of the marine biological Association of India, 1974 [1976]: 16(2): 462-490.

Bruce, A.J., 1976b. A report on a small collection of shrimps collected from the Kenya National Marine Parks at Malindi, with notes on selected species.— Zoologische Verhandelingen Leiden 145: 1-72, figs. 1-23, tabs. 1-5.

Bruce, A.J., 1976c. Coral reef Caridea and "Commensalism".— Micronesica 12 (1): 83-89, figs. 1-2.

Bruce, A.J., 1976d. A report on some pontoniinid shrimps collected from the Seychelles Islands by the F.R.V. Manihine., 1972, with a review of the Seychelles pontoniinid shrimp fauna.— Zoological Journal of the Linnean Society of London 59: 89-153, figs. 1-30, tabs. 1-8.

Bruce, A.J., 1976e. Shrimps and prawns of coral reefs, with special reference to commensalism.— In: O. Jones & R. Endean (eds), Biology and Geology of Coral Reefs 3 (2): 37-94, figs. 1-21, tab. 1.

Bruce, A.J., 1978a. A report on a small collection of Pontoniine shrimps from Queensland, Australia.— *Crustaceana* 33 (2): 167-181, figures 1-10.

Bruce, A.J., 1978b. A report on a collection of pontoniine shrimps from Madagascar and adjacent seas.— *Zoological Journal of the Linnean Society of London* 62: 205-290, figures 1-5.

Bruce, A.J., 1980. Shrimps: the complex life relationships of shrimps on the Great Barrier Reef.— *Geo* 2 (3): 38-53, 16 figs.

Bruce, A.J., 1981. Pontoniine shrimps of Heron Island.— *Atoll Research Bulletin* 245: 1-33.

Bruce, A.J., 1982. The shrimps associated with Indo-West Pacific echinoderms, with the description of a new species in the genus *Periclimenes* Costa, 1844 (Crustacea: Pontoniinae).— *Memoirs of the Australian Museum* 16: 191-216, figs. 1-8.

Bruce, A.J., 1983. The pontoniine shrimp fauna of Australia.— *Memoirs of the Australian Museum* 18: 195-218.

Bruce, A.J., 1991. Shallow-water palaemonoid shrimps from New Caledonia (Crustacea: Decapoda).— In: B. Richer de Forges (ed.), *Le benthos des fonds meubles des lagons de Nouvelle-Calédonie*, 1. Études et Thèses; Paris, ORSTOM: 211-279, figs. 1-31.

Bruce, A.J., 1993. Some coral reef pontoniine shrimps from Vietnam.— *Asian Marine Biology* 10: 55-75, figs. 1-6, 1 tab.

Bruce, A.J., 1996. Crustacea Decapoda: Palaemonoid shrimps from the Indo-West Pacific region mainly from New Caledonia. In: A. Crosnier (ed.), *Résultats des Campagnes MUSORSTOM*, Volume 15.— *Mémoirs du Muséum national d'Histoire naturelle* 168: 197-267, figs. 1-31.

Bruce, A.J. & A. Svoboda, 1983. Observations upon some pontoniine shrimps from Aqaba, Jordan.— *Zoologische Verhandelingen Leiden* 205: 1-44, figs. 1-15.

Cangini, C., 1998. *Sharm El-Sheikh, diving guide*: 1-167.— United Kingdom.

Castro, P., 1971. The natantian shrimps (Crustacea, Decapoda) associated with invertebrates in Hawaii.— *Pacific Science* 25: 395-403.

Coleman, N., 1977. *Field Guide to Australian Marine Life*: 1-223.— Australia.

Colin, P.L. & C. Arneson, 1995. *Tropical Pacific Invertebrates. A field Guide to the Marine Invertebrates occurring on tropical Pacific coral reefs, seagrass beds and mangroves*: i-viii, 1-296, figs.— California, U.S.A.

Darom, D. & F.D. Por, 1976. *De Rode Zee*: i-xxiv, 1-105.— Naarden, The Netherlands.

Debelius, H., 1982. *Grosskrebs im Aquarium*. 7. Teil: über die Gattung *Periclimenes*.— *Die Aquarium und Terrarium Zeitschrift* 35 (11): 424-428, illustr.

Debelius, H., 1983a. Die 'spanische Tanzerin' und ihr Untermieter. Die Nacktschnecke und der Krebs.— *Aquarien Magazin* 8: 1983: 433-436, illustr.

Debelius, H., 1983b. *Gepanzerde Meeresritter*: 1-120.— Essen, Germany.

Debelius, H., 1996. *Nudibranchs and Sea Snails. Indo-Pacific Field Guide*: 1-321, colourfigs.—IKAN, Germany.

Doubilet, D., 1975. Rainbow world beneath the Red Sea.— *National Geographic Magazine* 148 (3): 344-365.

Doubilet, D., 1989. *Light in the sea*: 1-168.— London.

Drogin, S.B., 1997. *Nudi of the week. The Slug Site*.—<http://siolibrary.ucsd.edu/slugsite/nudiwk01.htm>.

Erhardt, H. & H.A. Baensch, 1998. *Wirbellose. Meerwasser Altas*, Band 4: 1-1214, colourfigs.—Melle, Germany.

Fell, F.J., 1982. *Echinodermata*: 786-818.— In: S.P. Parker, *Synopsis and classification of living Organisms*, Vol. 2.— New York.

Fosså, S.A. & A.J. Nilson, 1998. Korallenriff-Aquaristik heute und morgen. Krebstiere, Stachelhäuter, Seescheiden und andere Wirbellose im Korallenriff und im Korallenriff-Aquarium. *Korallenriff-Aquarium* Bd. 6: 1-589.— Bornheim, Germany.

Fransen, C.H.J.M., 1994a. Marine palaemonoid shrimps of the Netherlands Seychelles Expedition 1992-1993.— *Zoologische Verhandelingen Leiden* 297: 85-152, figures 1-112, plates 1-4 (colour).

Fransen, C.H.J.M., 1994b. Shrimps and molluscs.— *Vita Marina* 42 (4): 105-113: figures 1-4, plates 1, 2.

Fransen, C.H.J.M., 1997. Indonesian pontoniinne shrimps: 1064-1075, figs. 21.6, 21.9-11.— In: T.

Tomascik, A.J. Mah, A. Nontji & M. Kasim Moosa (eds.), The Ecology of the Indonesian Seas, Part II, Box 21.3.

George, J.P. & J.J. George, 1979. Marine Life: 1-188.— London.

Hipeau-Jacquotte, R., 1972. Etude des crevettes Pontoniinae (Palaemonidae) associées aux mollusques Pinnidae à Tuléar (Madagascar); 6 pp, 1-212, figs. 1-16. (Thèse).

Hipeau-Jacquotte, R., 1973. Morphologie externe et morphologie des pièces buccales. Étude des crevettes Pontoniinae (Palaemonidae) associées aux mollusques Pinnidae à Tuléar (Madagascar). 3.— Téthys, suppl. 5: 95-116, figs. 1-8.

Hunziker, R., 1993. The magic of tropical shrimps.— Tropical Fish Hobbyist 41 (10): 32-50, colourfigs.

Jacquotte, R., 1964. Décapodes nageurs associés aux Echinodermes dans la région de Tuléar (sud-ouest de Madagascar). Notes de faunistique et de biologie marines de Madagascar II.— Recueil des Travaux de la Station Marine d'Endoume 48: 179-182.

Kalk, M., 1959. The Crustacea of Inhaca shores.— In: MacNae, W. & M. Kalk, A natural history of Inhaca Island, Moçambique: 64-83, figs. 15-18.

Kemp, S., 1922. Notes on Crustacea Decapoda in the Indian Museum. XV. Pontoniinae. - Rec. Indian Mus., 24: 113-288, figs. 1-105, pls. 3-9.

Laboute, P. & Y. Magnier, 1979. Underwater guide New Caledonia: 1-160.— Tahiti.

Li, X.-Z. & R. Liu, 1993. Pontoniine shrimps from Hainan collected by "Chinese-German Marine Biological Expedition".— Abstract volume International Senckenberg Symposium on Crustacea Decapoda: 36.

MacNae, W. & M. Kalk, 1962. The fauna and flora of sand flats at Inhaca Island, Mocambique.— Journal of Animal Ecology 31: 93-128, figs. 1-5.

Monod, T., 1968. Nouvelle capture du *Ligur uveae* (Borradaile) aux Iles Loyalty. — Bulletin du Muséum National d'Histoire naturelle, Paris (2) 40 (4): 772-778, figs. 1-8.

Müller, H.G., 1993. Catalogue of the Indo-Pacific Pontoniine shrimps: i-ii, 1-159, 1 fig.— Wetzlar, Germany.

Newbert, C., 1994. Within a Rainbow Sea (6th ed.): 1-208.— Oregon, U.S.A.

Patzner R.A. & H. Debelius, 1984. Partnerschaft im Meer: 1-120, figs. — Wuppertal, Germany.

Paolillo, V., 1997. Seychelles: 1-160.— Shrewsbury, England.

Rudman, W.B., 1998. Symbiosis and commensalism (IN) Sea Slug Forum.— www.austmus.gov.au/science/division/invert/mal/forum/symbio.htm.

Rudman, W.B., 1982. The Chromodorididae (Opistobranchia, Mollusca), of the Indo-West Pacific: *Chromodoris quadricolor*, *C. lineolata* and *Hypsodoris nigrolineata* colour groups.— Zoological Journal of the Linnean Society 76: 183-241.

Schmid, P. & D. Paschke, 1990. Unterwasserführer Rotes Meer. Niedere Tiere: 1-167.— Stuttgart, Germany.

Schmid, H., 1997. Sea Desert: 1-203.— Hong Kong.

Schumacher, H., 1973. Das kammensalische Verhältnis zwischen *Periclimenes imperator* (Decapoda, Palaemonidae) und *Hexabranchus sanguineus* (Nudibranchia: Doridacea).- Marine Biology 22: 355-360, fig. 1.

Schumacher, H., 1976. Korallenriffe. Ihre Verbreitung, Tierwelt und Ökologie: 1-275.— München, Germany.

Severns, M., 1994. Sulawesi Seas. Indonesian's magnificent underwater realm: 1-160.— Singapore.

Shoup, J.B., 1972. Notes on the behaviour of *Periclimenes imperator* Bruce, an ectocommensal on the nudibranch *Hexabranchus marginatus* (Quoy & Gaimard).— Crustaceana 23 (1): 109-111, pl. 1.

Steene, R., 1990. Coral Reefs Nature's richest realm: 1-335.— Australia.

Strack, H.L., 1993. Results of the Rumphius Biohistorical Expedition to Ambon (1990). Part 1. General account and list of stations.— Zoologische Verhandelingen Leiden 289: 1-72, figs. 1-65, pls. 1-4.

Vine, P., 1986. Red Sea Invertebrates: 1-224.— London.

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